Informal Analysis of Claims

What I claim:

1. A mini plasma display, comprising in combination:

This claim overall concerns a method for elimination of the thousands of address lines normally required by state of the art X-Y matrix addressed plasma displays by the substitution of electronic pulse transfer of a gas discharge along a recurring path using the inherent bistable nature and physics of a gas discharge. By my innovation only nine or less electrode connections are required to control the luminous gas discharge than the thousand or more connections used in standard X-Y addressed plasma displays. In addition the innovative use of a semiconductor (usually silicon) allows structural fabrication of the huge number of very tiny gas cavities required for a mini plasma display by the use of MEMS and VLSI semiconductor technology.

(MEMS-MicroElectroMechanicalSystems and VLSI-VeryLargeScaleIntegration are process technology terms used in the semiconductor industry).

(a) semiconductor substrate,

In state of the art plasma displays gas cavities are formed in materials like ceramics or metals and these materials are used in large-sized plasma displays. Forming small-sized gas cavities in these materials is almost impossible and this is why there are no mini plasma displays. The particular problem in a mini plasma display (about 2" X 2") is to be able to make very small-sized gas cavities in huge numbers (preferably a million or more). I am claiming the use of a semiconductor material for two reasons; because of the crystalline nature of semiconductor materials (especially silicon) which allows precise uniform cavity structures all the same and because MEMS and VLSI fabrication technology are particularly adaptable to fabricating the huge number of precisely positioned gas cavities required.

(b) gas containment cavity array formed in said semiconductor substrate,

This covers the general requirement for an array of gas cavities for the mini-display. The general term "formed" is used because the gas cavities would normally be chemically etched in the semiconductor using micromachining process technology but they could be formed by other means such as by plasma etching.

(c) columnar electrodes interconnecting gas cavities in groups,

As described in the specification the column electrodes can be in groups of 2,3, even four as previously disclosed in other patents (and my previous patent) for bistable gas plasma transfer. The column electrodes are not specifically designated as "cathodes" because from the standpoint of activation of the glow discharge it doesn't make any difference whether the electrodes are cathodes or anodes, the gas discharge breakdown effect is the same.

(d) row electrodes orthogonal to columnar electrodes interconnecting gas cavities in groups,

The row electrodes can be in groups, usually two, as previously disclosed in my previous patent to meet the requirements of frames for interlaced scanning television requirements. The row electrodes are not designated as electrodes and not as "anodes" because from the standpoint of activation of the glow discharge it doesn't make any difference whether the electrodes are anodes or cathodes, the gas discharge breakdown effect is the same.

(e) hermetic sealing and gas filling means,

glow discharge. There are many hermetic sealing means and I don't claim them in this general claim. Generally a front cover panel and a back panel are required and then these would have to be sealed at the periphery to make a hermetic package. This is old art and a hermetic package is always required to provide a gas discharge display of any type.

(f) electronic enabling means of said electrodes to allow activation of selected individual gas containment cavity providing luminous glow discharge of said individual gas cavity,,

One chosen cavity must be activated so as to initiate a glow discharge to start the scanning. By application of voltage to an electrode the gas in an individual cavity is caused to breakdown with consequent change to sustaining voltage. This is the essential "binary" (i.e., on-off) property of a gas discharge which allows the bistable transfer of the glow discharge from one cavity to the next. .

(g) electronic enabling means of said electrodes to allow bistable transfer of said luminous glow discharge from said individual gas cavity to subsequent gas cavities along a recurring path by pulsed sequential activation,

The electronic circuits controlling the columnar gas cavities in combination with the orthogonal row gas cavities are activated in sequence using electrical pulses as described in the specification and my previous display patent. This art is known and I am merely including it because it is required for functionality. This bistable method for transferring the glow discharge is required along a recurring path to meet the requirements of interlaced raster area scanning for television. I am using the term "raster pattern" because the scan could be interlaced lines, or perhaps circular scanning as required for RADAR, or any other pattern as required for a particular purpose. (Raster- in the dictionary is defined as "the area upon which the image is reproduced in the cathode-ray tube of a television pattern.")

wherein the improvement is a method for eliminating orthogonal X-Y addressing as well as a method of enhanced construction of a mini display panel of the plasma type.

These are the two main useful purposes of my innovation: to eliminate the thousands of address lines required for X-Y matrix addressing of a plasma display by the use of bistable pulse scanning which results in the requirement for only nine or less input electrodes for a mini plasma display and introduction of a structure which allows process technology particularly tailored to mass production and fabrication of huge numbers of very small gas cavities as required for a mini plasma display.

2. A mini plasma display, comprising in combination:

This claim introduces the innovation of the semiconductor substrate bonded to a transparent faceplate for providing the viewing side of the mini display. The innovative improvement is a hermetic sealing method whereby the luminous glow discharge may be fully viewed from the front, unobscured by electrodes and each individual gas cavity is hermetically sealed to the bonded glass faceplate around its full peripheral extent

(a) semiconductor substrate,

(b) transparent viewing faceplate bonded to said semiconductor substrate,

This will result in a new and better method for achieving the subsequent required hermetic sealing of a mini plasma display plus the added benefits of increased structural strength and fully visible pixels.

(c) gas containment cavity array etched in said semiconductor substrate wherein said gas containment cavities are bottomed and floored by said transparent viewing plate.

This specifically covers forming the gas cavities by etching methods. Usually the gas cavities are chemically etched in the silicon using micromachining process technology but they could be formed by other than chemical etching such as by plasma etching or a combination method could be used whereby

the cavities are first chemically etched then the final stage of the cavity could be etched using plasma etching to thereby assure non-attack of the glass viewing plate.

The innovation here is forming the gas cavities such that they are etched all the way through the silicon until the etching is stopped by the bonded transparent plate (which is usually a thin quartz glass plate). This structure introduces a new and better method to achieve the required hermetic sealing for a mini plasma display because it accomplishes two things: exposes the gas containment cavities to view so as to be able to see the luminous glow of the gas discharge in each fully exposed gas cavity pixel on the transparent faceplate side plus greatly increases the structural strength of the display whereby each individual gas cavity is bonded to the glass.

The transparent plate will become the viewing side of the mini display.

(d) electrodes interconnecting gas cavities in columnar array in cathode groups,

Now the column electrodes are specifically designated as interconnecting "cathodes" in this claim.

(e) back plate containing rows of anode electrodes in groups orthogonal to columnar electrodes,

Now the row electrodes are specifically designated as "anodes" in this claim.

(f) back plate containing said anodes orthogonally matched and aligned to face said cathode electrodes peripherally sealed hermetically to cathode plate including gas filling means,

This is new art. This innovation introduces a desirable new method for forming a hermetic package for a mini plasma display wherein the back panel containing the anodes is sealed to the front panel assembly. This requires alignment of the anodes orthogonally to the cathodes. Since the front plate structure is the silicon wafer with cavities plus the transparent viewing panel the luminous glow discharges can be fully exposed wherein each pixel is unobscured by anode electrodes, etc. Also, each gas cavity is hermetically sealed around its full edge on the bonded glass side. This adds a great deal of strength to the structure.

For operation of the gas plasma display air must be eliminated in the hermetically sealed mini plasma display container and then it must be back-filled with the gas required for forming the plasma glow discharge. This is old art.

(g) electronic enabling means of said electrodes to allow activation of selected individual gas containment cavity providing luminous glow discharge of said individual gas cavity,,

Described above.

(h) electronic enabling means of said electrodes to allowing bistable transfer of said luminous glow discharge from said individual gas cavity to subsequent gas cavities along a recurring path by pulsed sequential activation,

Described above.

wherein the improvement is a hermetic sealing method whereby the back panel containing the anodes is sealed to the front panel structure containing the cathodes and wherein the luminous glow discharge is fully visible and unobscured by electrodes plus the structural strength of the mini display is enhanced by each individual gas cavity hermetically bonded around its full peripheral extent to the transparent viewing faceplate.

3. A mini plasma display, comprising in combination:

(a) semiconductor substrate of at least two layers differing in etch rate properties wherein the respective etch rates control the dimensional size and therefore the volume of the gas cavity so formed in each layer and thereby allow hollow cavity structures,

Covers the use of two or more layers of semiconductor with different etch rate properties whereby one layer may be etched more quickly than the other, or may be etched more slowly than the other, or may not be etched at all compared to the other layer. This allows the construction of hollow cathodes. The function of hollow cathodes is described in the specification and generally they allow a brighter more intense luminous glow.

It is well known in the VLSI and MEMS art how to accomplish obtaining different etch rates in semiconductors as by diffusing one side of a semiconductor wafer wherein you end up with two layers of differing etch rate, or by depositing an epitaxial layer, or by ion implantation, or by inducing physical damage, etc. to change the etch rate properties of silicon as desired. This is old art, well known in the industry.

(b) transparent viewing faceplate bonded to said semiconductor substrate,

See above.

(c) gas containment cavity array etched in said layers of semiconductor substrate whereby said gas containment cavities in said semiconductor layers are axially coincident but differ in size extent and volume dependent upon respective etch rate of said semiconductor layers and wherein said gas cavities may be bottomed and floored by a semiconductor layer or by said transparent viewing side faceplate,

This claims new art wherein the respective etch rate of each layer controls the dimensional size and therefore the volume of the gas cavity so formed in each layer to thereby allow hollow cathode structures for greater luminosity,

(c) ionization slots each cavity in row direction said ionization slots allowing sustained glow discharge ionization extending to immediately preceding and immediately succeeding cavities in the row therein,

This art is not new and is covered, for example, in my prior patent. The use of a crystalline semiconductor and the use of MEMS and VLSI fabrication allows the uniformity advantages for achieving precise slots for the same reasons as described above for the gas cavities.

(d) cathode electrodes interconnecting gas cavities in columnar array in groups,

Described above.

(e) back plate containing rows of anode electrodes in groups orthogonal to columnar electrodes,

Described above

(f) back plate containing said anode electrodes orthogonally matched and aligned to face said cathode electrodes peripherally sealed hermetically to cathode plate including gas filling means,

Described above

(g) electronic enabling means of said electrodes allowing activation of selected individual gas containment cavity providing luminous glow discharge of said individual gas cavity,

Described above

(h) electronic enabling means of said electrodes to allowing bistable transfer of said luminous glow discharge from said individual gas cavity to subsequent gas cavities along a recurring path by pulsed sequential electrical activation as required for TV standard interlaced scanning,

Described above.

wherein the improvement is a method to achieve hollow cathode structures for enhanced glow discharge luminosity.

4. A mini plasma display of claims 1, 2, and 3 wherein said semiconductor substrate is silicon of <100> crystal orientation.

5. A mini plasma display of claims 2 and 3 wherein said semiconductor substrate is anodically bonded to said transparent viewing faceplate.

6. A mini plasma display panel of claim 3 wherein cavity array pattern is etched in top silicon layer whereby cavities so formed are used as etch mask to define cavities in underlying silicon layer whereby underlying cavities so formed are contingent to top layer cavities using top layer cavities as etch mask,

7. A mini plasma display panel of claim 3 wherein said silicon substrate is comprised of a top layer of silicon of slow etch rate in selected chemical on top of a silicon layer of enhanced etch rate which is in turn on top of transparent viewing faceplate to allow formation of hollow cathodes with enhanced dimensional extent on transparent viewing plate side..

These fabrication methods are state of the art in MEMS technology.

8. A mini plasma display panel of claim 3 wherein said silicon substrate is comprised of a top layer of silicon of enhanced etch rate in selected chemical on top of a silicon layer of reduced etch rate which is in turn on top of transparent viewing faceplate thus allowing formation of hollow cathodes with reduced dimensional extent on transparent viewing plate side.

These fabrication methods are state of the art in MEMS technology.

9. The mini plasma display panel of claim 6 wherein top silicon layer is doped P-type <100> and the bottom layer is N-type <100> silicon providing hollow cavities with enhanced dimensional extent on transparent viewing plate side for forming hollow cathode structures for increased lumens.

10. The mini plasma display panel of claim 7 wherein top silicon layer is N-type <100> and the bottom layer is P-type <100> silicon providing hollow cavities with reduced dimensional extent on transparent viewing plate side for forming hollow cathode structures for increased lumens.

11. The mini plasma display of claim 3 wherein said gas containment cavity array pattern is etched in top silicon layer until bottomed by etch-resistant under-layer of silicon thereby providing desirable flat-bottomed gas cavities of precise dimensions for an improved IR display.

By this claim a method is disclosed for an IR imager whereby a glow discharge may be stepped in a recurring pattern but the luminosity can only be detected at IR wavelengths through the silicon layer which is IR transmissive but opaque to visible light.

12. The mini plasma display of claim 10 wherein said gas containment cavity array pattern is etched in top silicon layer of N-type <100> until bottomed by etch-resistant under-layer of highly doped P-type <100> silicon thereby providing desirable flat-bottomed gas cavities of precise dimensions for an improved IR display.

13. The mini plasma display of claims 2 and 3 whereby viewing of said glow discharge from said transparent faceplate side is unobstructed by electrode elements.

14. The mini plasma display of claims 1, 2, and 3 further including at each pixel element transparent electrodes for activation of selected color phosphors whereby signal activation in scanned synchronism with luminous gaseous discharge of phosphors at selected pixel elements provides light and color values in correspondence with supplied television signal means.

15. The mini plasma display panel of claims 2 and 3 wherein said array pattern of gas containment cavities in silicon bonded to transparent viewing plate provides increased structural strength allowing increased gas pressure in said cavities at hermetic sealing for increased lumens.

16. The mini plasma display panel of claim 1, 2, and 3 further including electrical enabling means activating glow discharge scanning comprising television field and frame timing pulses applied to selected columnar electrodes, connected in groups of three, and row anode electrodes to cooperatively provide a recurring bistable transfer of the luminous glow discharge in a raster pattern in synchronism with supplied television signals.

17. The mini plasma display panel as defined in claims 1, 2, and 3 wherein the scanned gas discharge light pixels of increased lumens are used as a scanned lighting source to cooperatively provide a recurring raster pattern for a LCD display.

18. The mini plasma display panel as defined in claims 1, 2, and 3 wherein the scanned light pixels of increased lumens are used as an areal lighting source.